INTRA - COMPANY CORRESPONDENCE

CONSOLIDATED VULTEE AIRCRAFT CORPORATION
SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

DATE 12 April 1948

TO Mr. K. J. Bossart

FROM Mr. V. Welge

SUBJECT Progress Report - Ground-to-Ground Missile, MX-774B

REFERENCE

PART I - NAVIGATIONAL AND GUIDANCE SYSTEMS AND COMPONENTS

A. SUMMARY OF WORK CONDUCTED DURING THE PERIOD 1 FEBRUARY TO 1 APRIL, 1948

1. Hypergrid Control System

a. Long-Range Low Frequency System

The report entitled "Hypergrid Navigation System Project Completion Report" has been completed and is being released as CVAC Report No. ZN-6002-008.

2. Magnetic Navigation and Experiments

With the completion and issuance of the reports outlined in the previous bi-monthly progress report, all work on the development of magnetic navigation has been concluded under this contract.

3. Investigation of Long Range Trajectories

Work is proceeding on the compilation and editing of the project completion report covering the investigation of long range trajectories.

In the early work on this project the trajectory equations were adapted to surface flights on a non-rotating spherical earth. These have been fully revised and are now adapted to flights between shut-off and target points in differing latitudes and elevated above the rotating spheroidal earth, in vacuum. They apply to ranges fixed in inertial space in a plane containing the center of the earth, the shut-off point at shut-off time, and target point at impact time, considering the displacement of the target point by earth rotation during time-in-flight. The slight warping of this plane due to revolution of the earth around the sun during the flight time has not been rigorously considered since it appears to be a small factor in the over-all permissible error at the target. Without requiring revision of the equations previously set up for the elliptical space path, this factor may be eliminated by a simple geometrical determination of the drifted space position of the target for the date and duration of the flight.

Since the elliptical form of the orbit results from the rigorous inverse square law which has slight imperfections when applied to free bodies near the earth, some choice of gravitational constant differing slightly from the experimentally determined surface value in the locale must be made. This choice is to be guided by the data from flights made with actual missiles. The result with the equations then will be a spurious elliptical orbit which intersects the actual warped flight orbit at the shut-off and target points. The geometrical intersections thus may be made exact by guided choice of gravitational constant, but the time-in-flight derived from the equations is yet to be shown to agree exactly with the experimentally-determined flight time of an actual missile.

4. Precision Missile Tracking System

a. VHF Position Tracker (Phase Comparison Angle Tracking System)

Following the successful system tests reported in the preceding bi-monthly progress report, emphasis was placed upon the study of the test results and the compilation of information concerning tests and equipment.

A report entitled "Phase Comparison Angle Tracking System", (CVAC Report No. ZN-6002-017), is in process of compilation. This report describes the testing of the equipment and the system, and is scheduled to be released during the ensuing report period.

A second report is being prepared which describes the computer used as a coupling unit between the phase comparison angle tracking system and the command control system for the operational tests. This report also describes a computer designed for use in MX-774 test vehicle guidance.

b. Doppler Speedometer Experiments and Design

The Doppler speedometer TRF repeater-transceiver has been modified to include a stepping relay to operate the fuel shut-off solenoid, the parachute release mechanism, and the detonating charge, in that sequence. This unit also was packaged in a pressurized container and fitted with pressurized electrical plugs. After a final operational check of the system it was determined that the fuel shut-off relay was actuated with signal strengths as low as 10 microvolts. A view of the final model of the repeater-transceiver is shown in Photograph T-7975.

In addition to the work on the repeater unit, a new phase-modulated exciter for the ground station transmitter was built to increase the stability of the unit. A self-contained 70-kc oscillator was provided in the unit to supply the signal for operating the stepping relay in the repeater transceiver.

Work is continuing on the project completion report entitled "Doppler Speedometer System" which will be released as CVAC Report No. ZN-6002-018. This report covers the development, construction, operation and testing of the complete Doppler speedometer system.

c. Doppler Range Measurement

Work on this project during the period covered by this report consisted principally of performance tests which were run on units of the Doppler range measurement system to provide more up-to-date and complete data for inclusion in the project completion report. This report, entitled "CVAC Precision Range System", CVAC Report No. ZN-6002-019, will be issued during the ensuing bimonthly work period, and will consist of a comprehensive summary of the development, operation and testing of the system.

d. Command Control System

With the completion of the operational and flight tests reported in the previous bimonthly progress report, work on the Command Control System has been concluded.

CONSOLIDATED VULTEE AIRCRAFT CORPORATION
SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

B. STATEMENT OF PROGRAM PLANNED FOR WORK IN THE NEXT PERIOD

1. Hypergrid Control System

Release of Report No. ZN-6002-008, entitled "Hypergrid Navigation System Project Completion Report."

2. Investigation of Long Range Trajectories

Preparation and release of project completion report.

3. Precision Missile Tracking System

a. VHF Position Tracker System

Compilation and release of project completion report CVAC No. ZN-6002-017, entitled "Phase Comparison Angle Tracking System," and a report describing the computer used as a coupling between the tracking system and the command control system.

b. Doppler Speedometer Experiments and Design

Compilation and release of project completion report entitled "Doppler Speedometer System," CVAC No. ZN-6002-018.

c. Doppler Range Measurement System

Compilation and release of project completion report, CVAC No. ZN-6002-019, entitled "CVAC Precision Range System."

CONSOLIDATED VULTEE AIRCRAFT CORPORATION
SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

PART II - SUPERSONIC TEST VEHICLE

A. SUMMARY OF WORK CONDUCTED DURING THE PERIOD 1 FEBRUARY TO 1 APRIL 1948

1. Stabilization Control System

a. Equipment Installation

During the period covered by this report, extensive simulator tests have been completed on the No. 1 Flight Missile stabilization panel assembly. The system has been removed from the simulator and final wiring changes are now being made before installation in the missile.

b. Amplifiers

Operational tests were run on the amplifiers prior to the firing of the Static Test Missile at Point Loma. A characteristic performance curve is shown in Figure No. 1. The amplifier installation on the flight missile panel is shown in Photograph No. T-8263. Covers are removed to permit continuous operation of the units without overheating during the tests.

c. Gyro Development

The telemetering and stabilization gyros now are being overhauled for installation in Flight Missile Number 1. Extensive operation of these units in the ground test missile on Point Loma has made a thorough overhaul desirable. These gyros were operated approximately 20 hours during the testing with no difficulties of any kind being encountered in the stabilization gyros. One motor failure and one potentiometer failure were experienced in the telemetering gyro operations.

d. Solenoid Control Valve Assembly

Calibration curves on the control valves installed in the Static Test Missile are shown in Figures No. 2, 3, and 4. It is planned to use these control valves in the Number 1 Flight Test Missile. During the firing tests on Point Loma, the valve block became fouled with a gum from the alcohol fuel, necessitating overhaul and cleaning. Future tests will be conducted using regular AN-18 alcohol which does not form the gum residue.

The valve block unit has been re-assembled for the Number 1 Flight Missile and potentiometers have been added to be used in telemetering the valve position in flight.

e. Integral Correction and Servo Response Units

The pitch, roll and yaw integral correction and response units are being cleaned and re-checked for installation in Flight Missile Number 1. During the Point Loma firing tests, a failure occurred in the pitch integral correction unit connector, which shorted the integral drive motor circuit to ground. These high voltage leads are now being brought out on separate wiring with quick disconnects. This improvement, with better insulation, should prevent future trouble of this kind.

f. Point Loma Firing Tests

During the period covered by this report, Static Test Missile firing tests, numbers 5, 6, and 7, were conducted with the stabilization system in operation in the missile.

The purpose of these tests was to provide a check of the stability of the system under firing conditions with power to the servo system being furnished by the missile fuel system as in actual flight.

Tests No. 5 and 6 were not satisfactory. In Test No. 5 the missile was restrained in pitch and yaw and free in roll. During the test the nose restraining cables failed and the run was cut short. In Test No. 6 the missile was free in pitch, yaw and roll. In the first few seconds after the missile was fired, pressure in the fuel system was too low for operation of the stabilization system. During this interval of instability, large oscillations built up, making shut-down necessary.

How about sticky valve?

In Test No. 7, operation of the stabilization system was very satisfactory. Test apparatus for this test was arranged to simulate actual missile launching conditions. Figure No. 5 shows the general arrangement of the missile and the test tower. A holding bar with an automatic release mechanism was used to hold the missile in position until the rockets came up to required pressure. The release mechanism was operated by the regular missile launching circuit which is energized by a pressure switch connected to rocket chamber pressure. Approximately 3-1/2 seconds after firing, the fuel pressure and chamber pressure reached a point within 80 percent of full pressure which is the missile release point. The stabilization system operated normally under this condition and the missile was satisfactorily stable throughout the run of approximately 55 seconds duration.

With the missile free in pitch, yaw and roll, the maximum oscillations during the test were as follows:

Pitch	Plus/minus 1/2 degree
Yaw	Plus/minus 3/4 degree
Roll	Plus/minus 1/4 degree

The excessive oscillation in yaw was believed due to a different adjustment of the rate gyro. In order to determine the effect of varying the rate signal, the yaw rate gyro was adjusted to give a rate output signal of 1/2 the pitch output signal per degree-per-second rate. All other constants of the pitch and yaw systems are similar. The results of this test and earlier simulator tests show the pitch rate setting of 0.1 volts-per-degree-per-second rate to be the most satisfactory.

~~Results of the operation of the system during the test is shown in the reproduction of telemetering records, Figure No. 6.~~ The original plan for the firing tests was to include step function disturbances in pitch, roll and yaw. During the test, however, the test program switch drive motor stopped before the step-disturbances switches were actuated. Cause of the failure was an open circuit ~~between the condensers~~ in the 400-volt supply to the motor. The step disturbances will be included in the static firing test program for the Number 1 Flight Missile now being assembled.

g. Simulator Tests

Very similar results have been obtained in tests on the water-jet missile simulator, firing tests on the missile, and dynamic calculations on the Analog Computer, for the pitch and yaw systems. Additional simulator tests and an investigation of the possible friction in the roller path on the missile test stand will be made to re-check the roll system. Results of computations on the Analog Computer indicate the present roll rate gyro output may be reduced.

2. Telemetering for ATV

Work on the telemetering program for the period covered by this report consisted primarily of the following; re-installing and checking out the telemetering equipment in the Static Test Missile and the ground station truck, telemetering of stabilization and dynamic tests, the making of major changes in the installation in order to obtain information pertinent to the test being conducted, and the completion of the telemetering transmitters for the No. 1 Flight Missile except for final adjustments and calibrations of the sub-carrier oscillators.

As indicated in the previous bimonthly progress report, it was necessary to re-install some of the telemetering and recording equipment in the ground station truck. The recording oscillographs were re-aligned together with the discriminator, and the entire ground station truck installation was re-calibrated.

CONSOLIDATED VULTEE AIRCRAFT CORPORATION
SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

In the process of checking out the re-installed telemetering equipment in the Static Test Missile, wiring discrepancies were noted in three channels; yaw gyro, roll master cylinder position, and roll tab position. The yaw gyro channel and roll master cylinder position channel were wired into the commutator. However, after a few tests it was determined that this commutated information was insufficient for satisfactory operation. In order to remedy this situation, direct wires were run from the missile to the telemetering truck. During the making of the stabilization and dynamic tests, additional telemetered information was requested which necessitated additional direct wiring from the missile to the telemetering truck. The final telemetering arrangement used on Hot Run No. 7, (and all test and calibration runs relative to it), was as follows:

(a) Roll valve position - telemetered continuously
(b) Roll cylinder position - telemetered continuously
(c) Roll gyro position - telemetered continuously
(d) Roll valve input signal - direct-wire recorded continuously
(e) Yaw valve position - telemetered continuously
(f) Yaw cylinder position - telemetered continuously
(g) Yaw gyro position - direct wire, recorded continuously
(h) Yaw valve input signal - direct wire, recorded continuously
(i) Pitch valve position - telemetered continuously
(j) Pitch cylinder position - telemetered continuously
(k) Pitch gyro position - telemetered continuously
(l) Pitch valve input signal - direct wire, recorded continuously
(m) Roll integral response - telemetered twice per second
(n) Yaw integral response - telemetered twice per second
(o) Pitch integral response - telemetered twice per second

Satisfactory recording were obtained of all functions telemetered during the hot and cold runs conducted at Point Loma in the period covered by this report.

Work is progressing on the construction of the telemetering transmitters for Flight Missile No. 1, with the units completed except for final adjustments and calibrations of the sub-carrier oscillators.

3. Radar Beacon

Work has been completed on the first model of the radar beacon. In clearing up the noise present in the final design of the beacon, it was decided to use electrolytic condensers which are protected against low temperatures by means of a 16-mfd condenser heating unit with thermostat control. These units have been installed and tests are being conducted in order to determine adjustments of the thermostat switch controlling the 16-mfd condenser heater, and to determine the effect of temperature variation on the condensers.

The work of compilation is continuing on the radar beacon instruction manual.

B. STATEMENT OF PROGRAM PLANNED FOR WORK IN THE NEXT PERIOD

1. Stabilization Control System

a. Equipment Installation

Continue preparation of the stabilization panel assembly for the Number 1 Flight Missile.

b. Amplifiers

Complete checkout with Flight Missile Installation.

c. Gyro Development

Installation and testing of gyros for Flight Missile No. 1.

d. Solenoid Control Units

Testing on Flight Missile No. 1.

e. Integral Correction and Response Units

Complete overhaul and installation of units in Flight Test Missile No. 1.

f. Simulator

Continue testing of Roll System

g. Test Equipment

Overhaul missile test panel and prepare for missile firing.

2. Telemetering in ATV

Complete construction of the telemetering units to be used in Flight Missile Number 1.

3. Radar Beacon

Complete testing of radar beacon.

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

Memo to: Mr. K. J. Bossart 12 April 1948
Subject: Ground-to-Ground Missile MX-774B
Progress Report

NAME	NAME	NAME
*Abel, C. F.	*Emig, I. L.	*Rogers, S.
*Abramis, B. D.	*Forbes, J. G.	*Schart, W. J.
Allen, H. A.	*Green, J. D.	*Seastrom, D. S.
*Block, K. A.	*Griffin, S. J.	Seibert, H. E.
*Brennan, W. E.	*Griggs, J. R.	Smith, R. A.
*Burdock, S.	*Ingalls, H. M.	*St. Martin, L.
*Burley, R. M.	*Humphrey, P. E.	Stegen, R. S.
Crooks, Jr., J. W.	*Kittel, R. P.	*Thompson, W. V.
Davis, W. F.	*Leslie, M. C.	*Ulmer, H. W.
*Dickson, J. A.	*Leinbach, H. M.	*Weaver, R. C.
*Dobler, L. R.	McCharles, J. R.	*Wehrman, R.
Dozier, C. T.	*McMahon, J. E.	*Werner, R. V.
*Eilers, H. B.	*Nicholas, J. C.	*Welge, V.
	*North, W. C.	

* Denotes Part Time on Other Guided Missile Projects

PART IV - PROJECT CONTACTS

A. VISITORS TO CVAC RADIO AND ELECTRICAL LABORATORIES DURING THE SUBJECT REPORT PERIOD

NAME	ACTIVITY	PURPOSE OF VISIT
I. J. Gabelman	Watson Laboratories	Discuss MX-774 Tests and Guidance
J. F. Raney	Aircraft Radiation Labs., AMC	Discuss MX-774 Tests and Guidance
J. W. Brandon	Guided Missiles Section, AMC	Discuss MX-774 Tests and Guidance
C. Peirce	Western Field Office - Eng. Div., AMC	Discuss MX-774 Tests and Guidance
P. H. Kemmer	Western Field Office - Eng. Div., AMC	Discuss MX-774 Tests and Guidance
B. W. Lantz	North American Aviation	Discuss MX-774 Tests and Guidance
V. S. Roddy	Hq., USAF	Discuss MX-774 Tests and Guidance

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

Memo to: Mr. K. J. Bossart 12 April 1948

Subject: Ground-to-Ground Missile MX-774B
Progress Report

PART V

The following photographs were made of equipment constructed under the MX-774 project during the subject report period, 1 February to 1 April 1948.

NUMBER	TITLE
T-7910	MX-774 - Radar Beacon - Mark II - In Mount
T-7911	MX-774 - Radar Beacon - Mark II - Top
T-7912	MX-774 - Radar Beacon - Mark II - Bottom
T-7930	MX-774 - High Pass Constant K Filter - Range Measurement Equipment
T-7973	MX-774 Automatic Computer Programming Mechanism - One Test Cam In Place - Construction Suspended
T-7974	MX-774 Automatic Computer Programming Mechanism Cam Drives- Construction Suspended
*T-7975	MX-774 Doppler Missile Repeater Transmitter - Top
*T-7976	MX-774 Doppler Missile Repeater Transmitter - Bottom

* Denotes Inclusion With This Report

SECRET

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

SAN DIEGO DIVISION . . SAN DIEGO, CALIFORNIA

Memo to: Mr. K. J. Bossart — 12 April 1948

Subject: Progress Report - Ground-to-Ground Missile MX-774B — Page 14 13

PART VI - LIST OF DRAWINGS

The following drawings were made for the MX-774 project during the subject report period, 1 February to 1 April 1948.

Title	Drawing No.	Size	Date
Circuit Diagram - MX-774 Stabilization Amplifier and Solenoid Test Unit	6002-970000	D	3-15-48

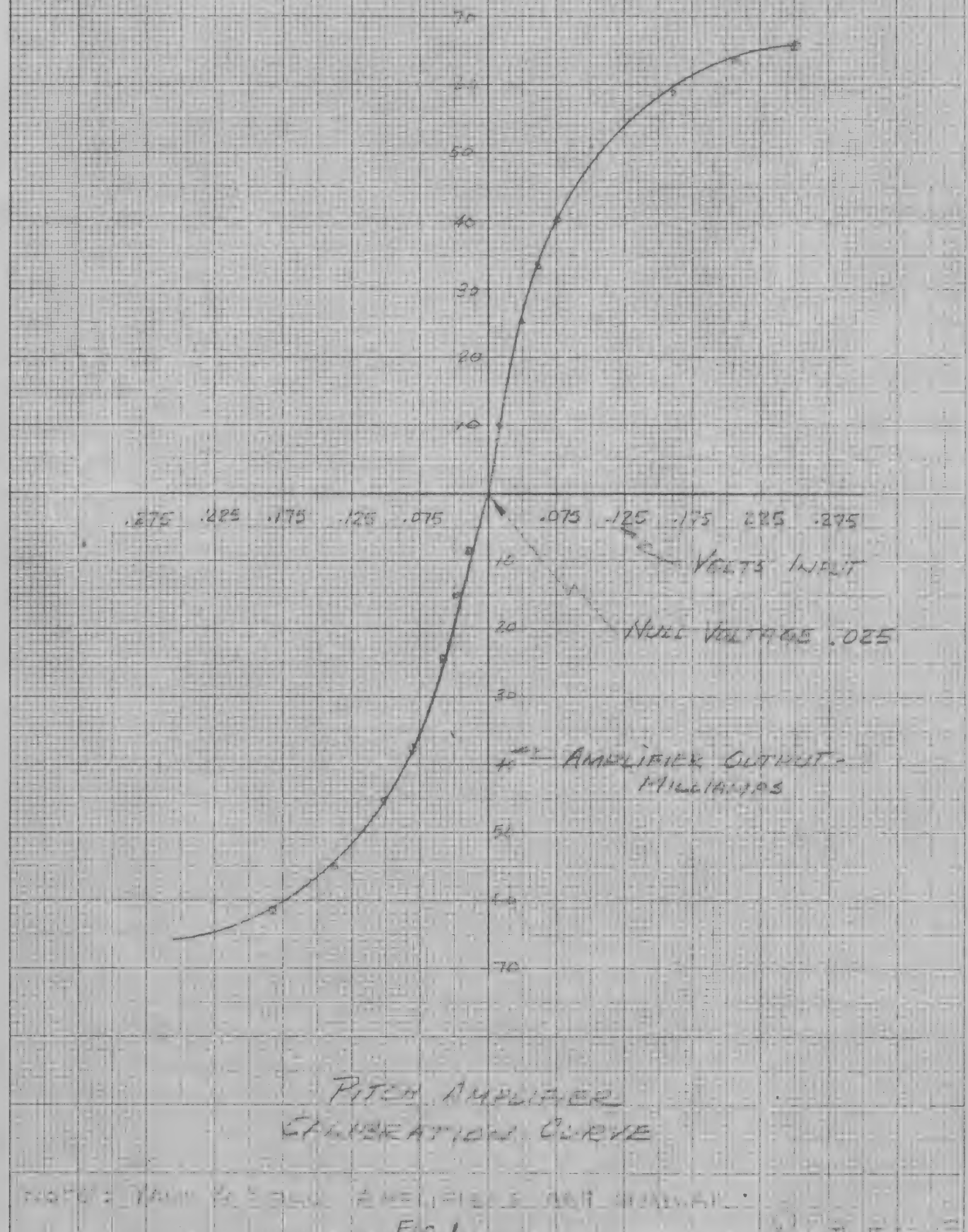
(Signed) V. Welge

V. Welge,
Chief of Radio and Elect. Laboratories
Consolidated Vultee Aircraft Corporation

cc: Addressee
V. Welge
R. and E. Labs.

SECRET

MK 24 STABILIZATION SYSTEM
CONSOLIDATED VULTEE AIRCRAFT CORP
AMPLIFIER & ELECTRICAL CALCULATORS

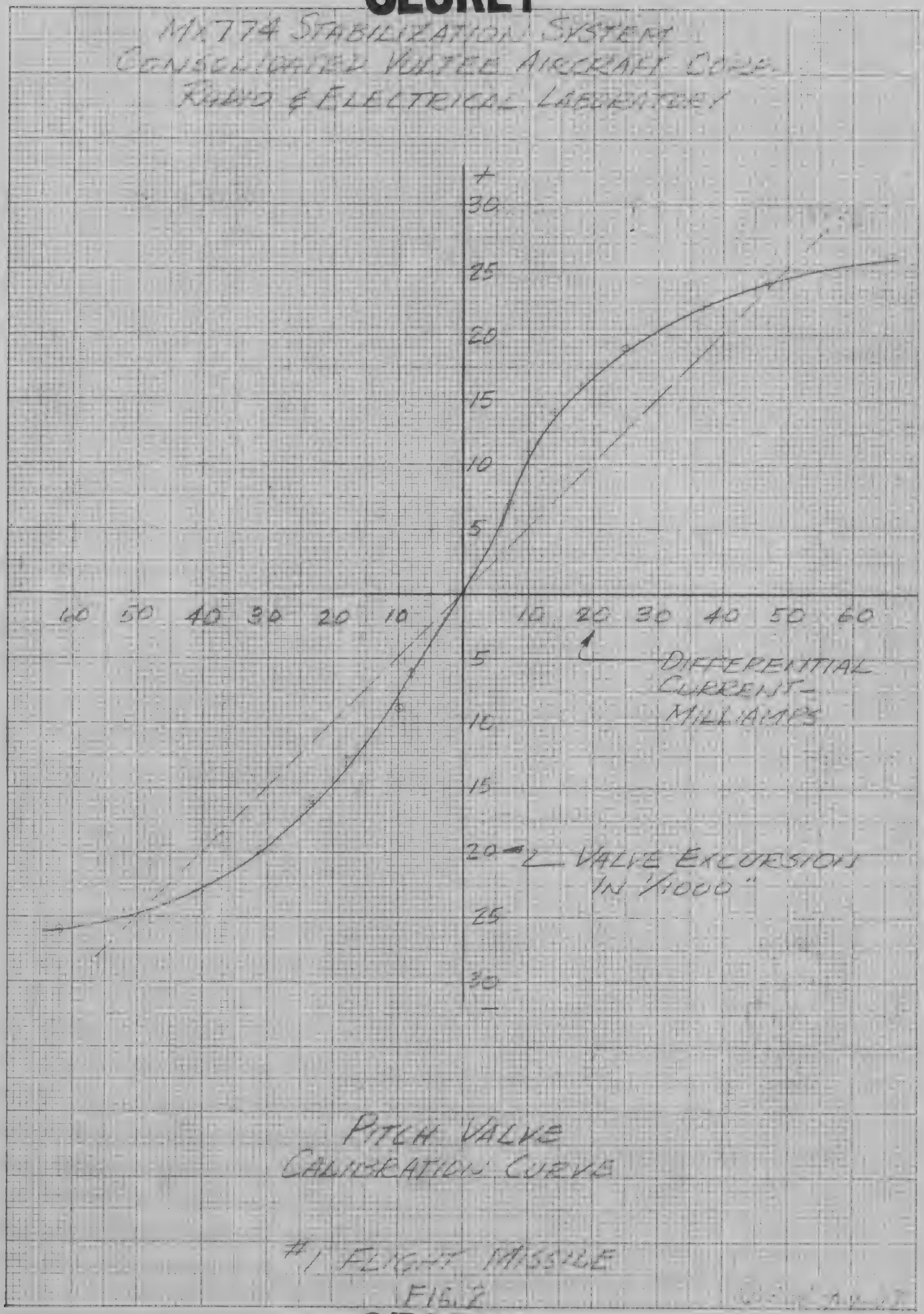


PITCH AMPLIFIER
CALIBRATION CURVE

FIG. 1

SECRET

MX 774 STABILIZATION SYSTEM
CONSOLIDATED VULTEE AIRCRAFT CORP.
RADIO & ELECTRICAL LABORATORY



PITCH VALVE
CALIBRATION CURVE

#1 FLIGHT MISSILE

FIG. 2

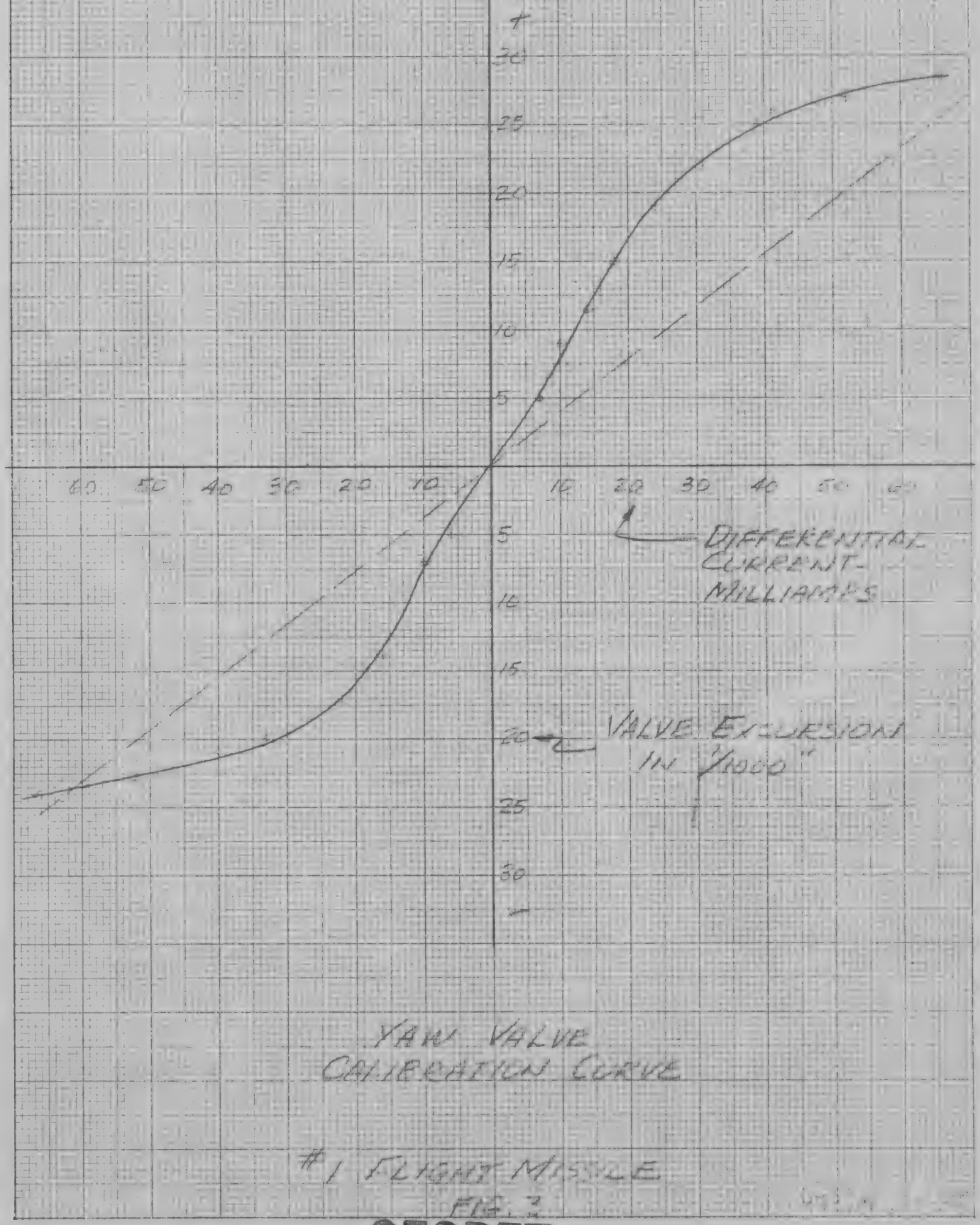
SECRET

DATA SHEETS

CHARLES BRUNING COMPANY, INC. NO. 700-20
20 x 20 to the inch.

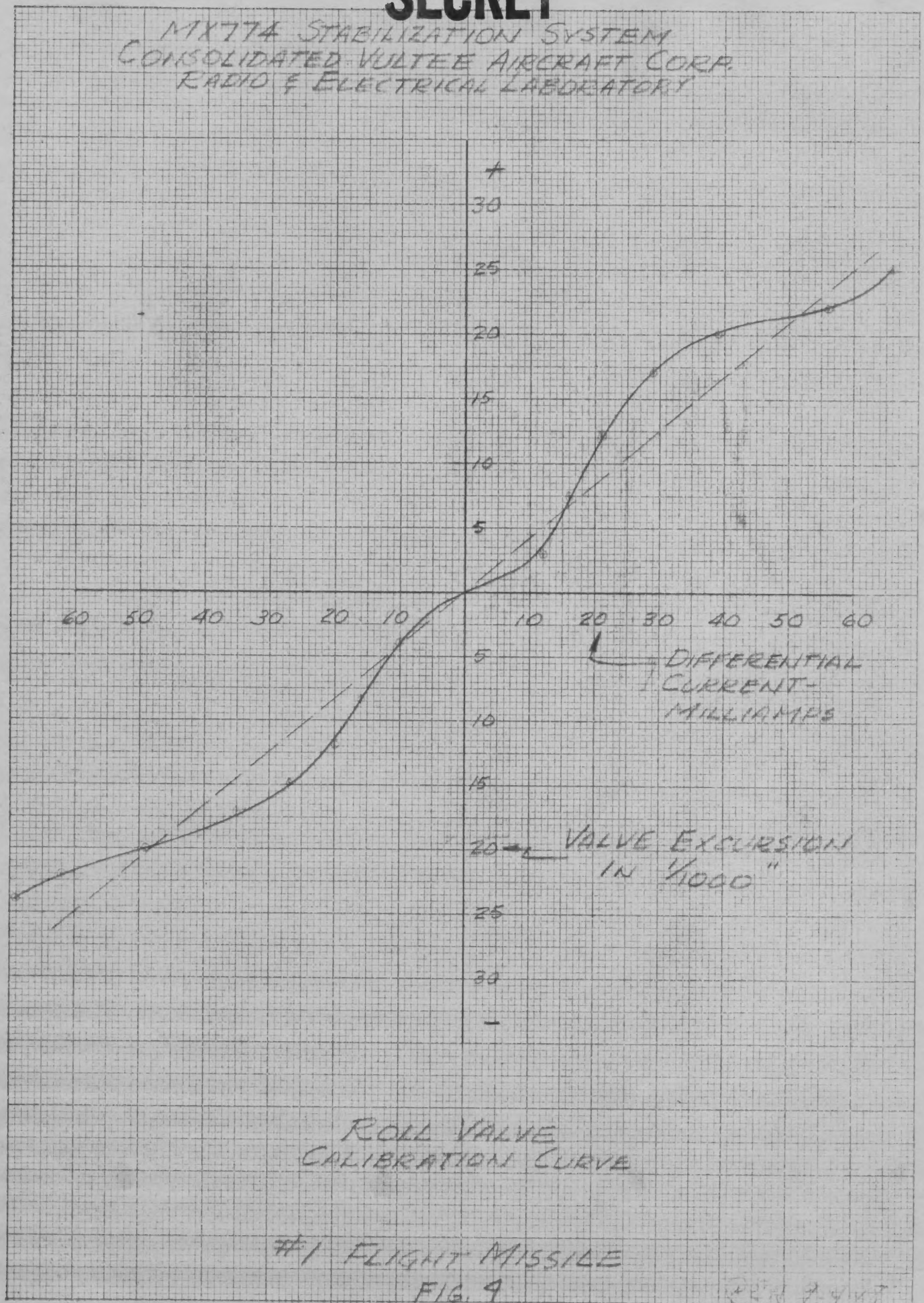
PRINTED IN U.S.A.

MX774 STABILIZATION SYSTEM
CONSOLIDATED VULTEE AIRCRAFT CORP.
RADIO & ELECTRICAL LABORATORY



YAW VALVE
CALIBRATION CURVE

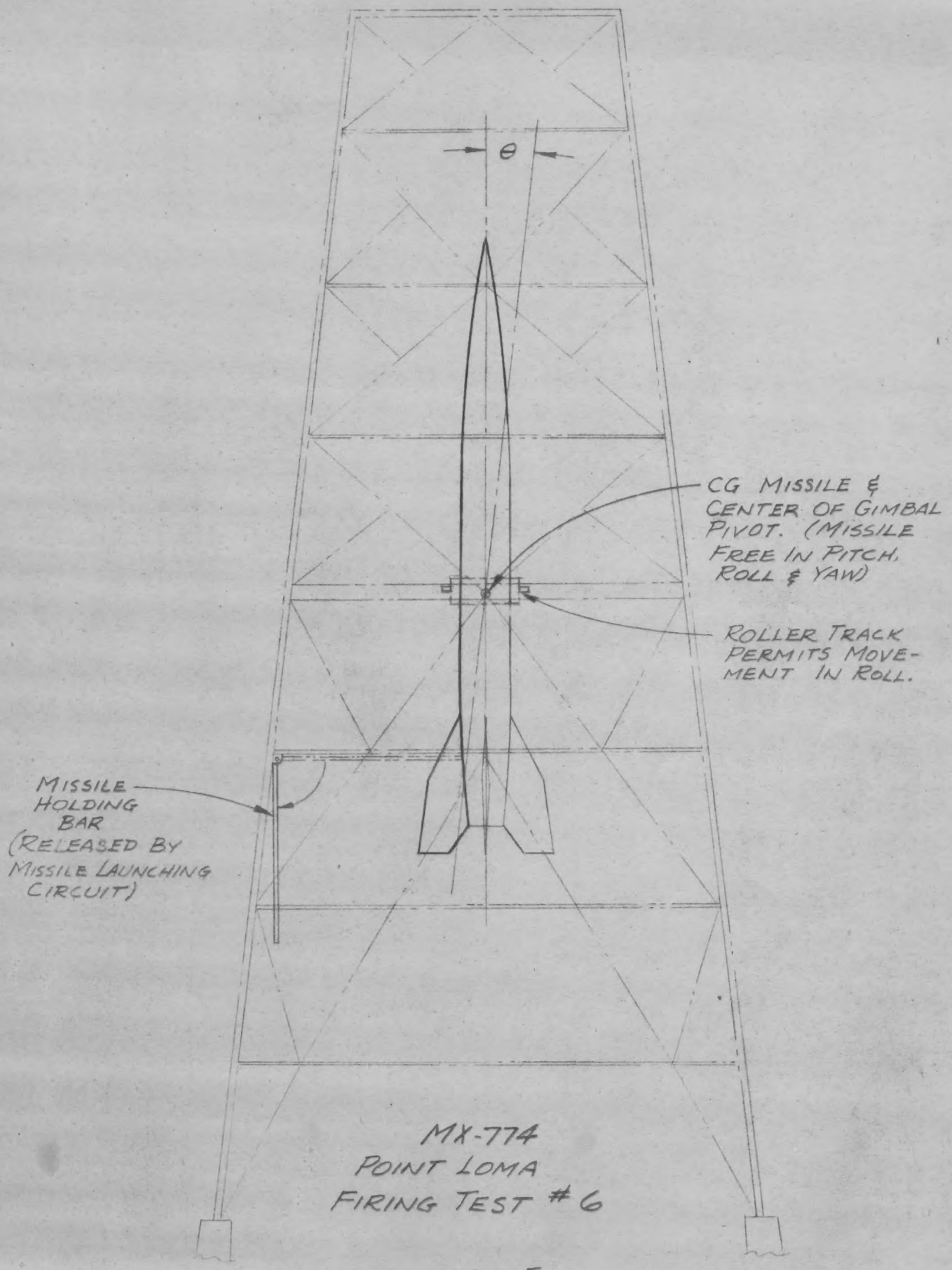
#1 FLIGHT MISSILE
FIG. 3



ANALYSIS
PREPARED BY
CHECKED BY
REVISED BY

CONSOLIDATED VULTEE AIRCRAFT CORPORATION
SAN DIEGO DIVISION

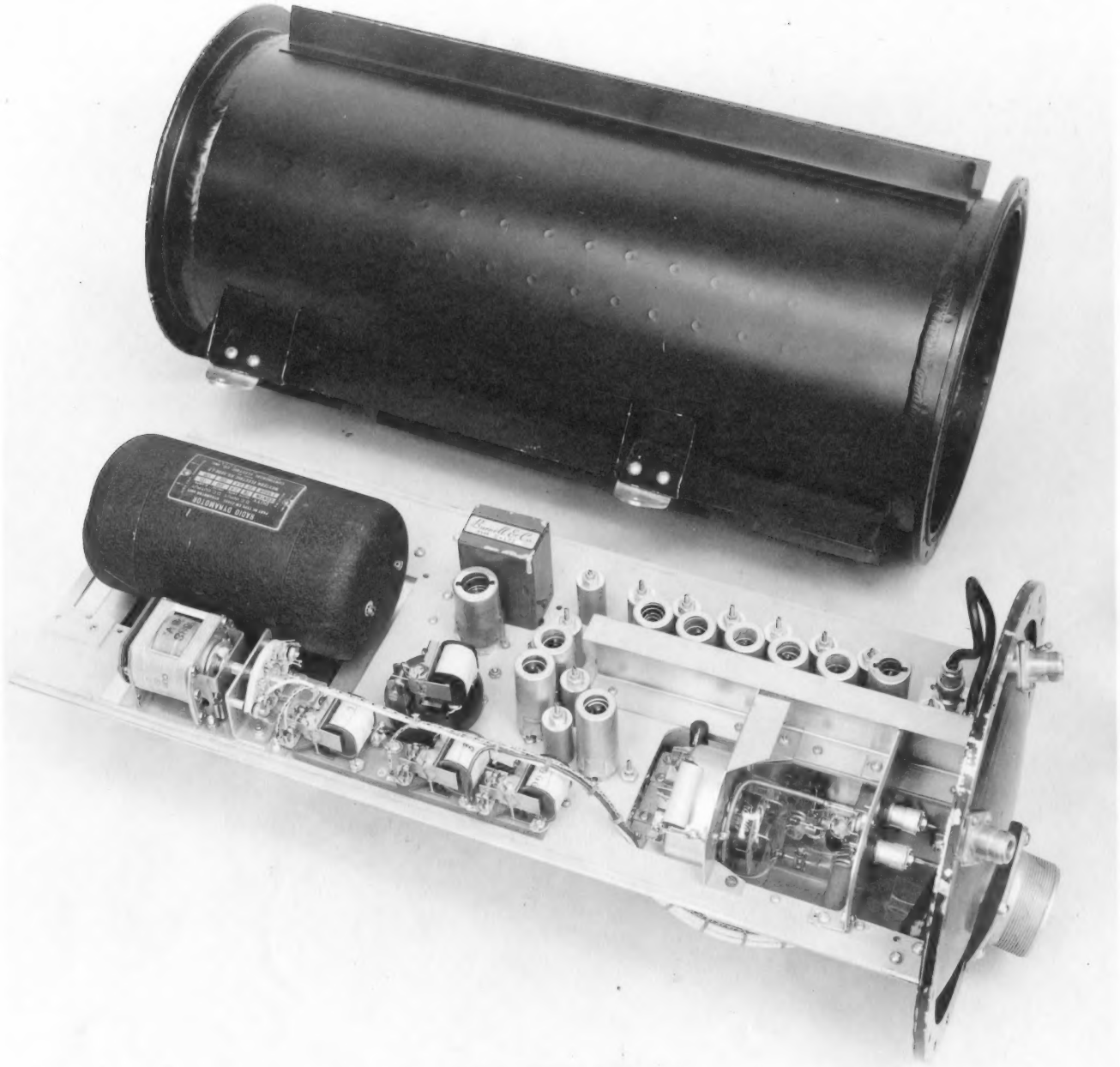
PAGE
REPORT NO.
MODEL
DATE



MX-774
POINT LOMA
FIRING TEST #6

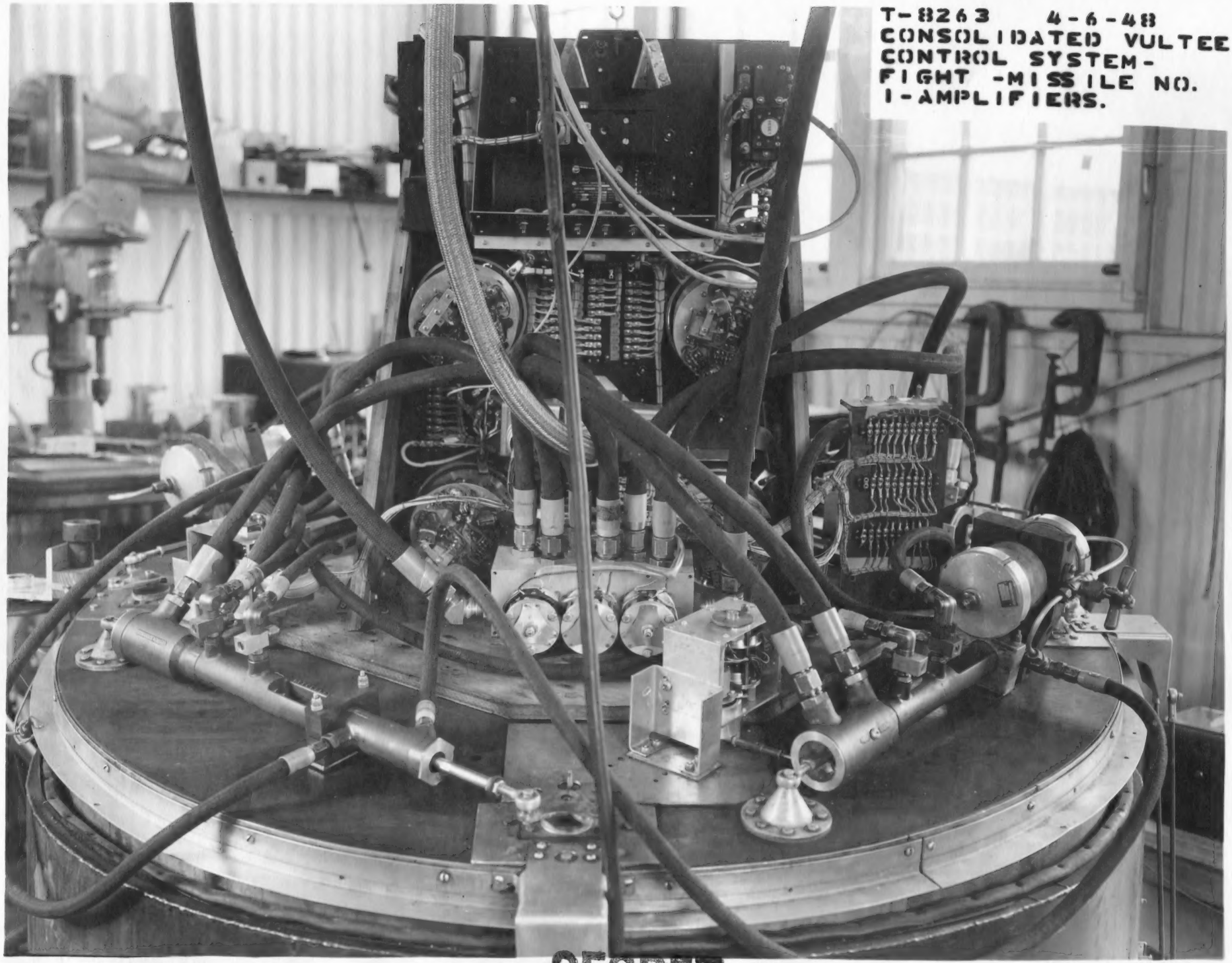
FIG. 5

GO 241-1



T-7975 3-3-48
CCONSOLIDATED VULTEE
MX-774 DOPPLER MISSILE
REPEATER TRANSMITTER TOP.

SECRET



T-8263 4-6-48
CONSOLIDATED VULTEE
CONTROL SYSTEM-
FIGHT -MISSILE NO.
1-AMPLIFIERS.

SECRET